Masters Thesis

Assessment of metadata associated with geotag pictures

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List of Acronyms

API	Application Programming Interface
EXIF	Exchangeable image file format
HTML	HyperText Markup Language
PHP	Hypertext Preprocessor

1. Introduction

The goal of this research is to study the metadata associated with geotag pictures uploaded to social networking websites. In the following sections we describe the research background, motivation, and the methodology.

1.1. Background

The past decade web has seen a major transformations in development and design to facilitate a user interactive environment commonly referred as Web 2.0. Web 2.0 services include web-based communities, hosted services, social-networking sites, media-sharing sites, wikis, bogs and mashups. Member contributions feed these online communities and are the force behind the increased volume of multimedia resources that are available on the web. In 2006 Time Magazine selected users of Web 2.0 for 'esteemed person of the year' award for their active involvement in generating web resources and shaping these resources into collective intelligence.

Tagging received wide adaptation among various Web 2.0 services such as blogs, photos, music, videos and social book-marking and has become increasingly popular in recent years. It is defined as the process of adding freely chosen set of keywords (tags) to a resource. These keywords help to mark ownership, browse, categorize and retrieve resources. Tagging becomes social tagging when the individual tags shared among other users of community. This sharing of tags often creates a rich network of shared tags, resources and users [3]. This process is also referred as collaborative tagging. Tagging has no predefined taxonomic structure and relies on social structures and behaviors, as well as related conceptual and linguistic structures of the user community [Kessler, 2009]. Based on this nature tagging systems are termed as folksonomy [Weinberger, 2008]. Folksonomy is defines as folk + taxonomy which means user generated taxonomy. They are classification schemes that emerge from collective actions of users on

web who describe resources with unrestricted set of keywords (tags). The popularity of folksonomy was also due to the change in the role of user in the emerging technologies of social web (Bashir & Kuhn, 2007). Majority of websites that allow tagging of resources often display their entire tag collection as tag clouds[1] based on popularity, topic, of interest, temporal aspect and location. Tags clouds are the most popular method to visualize tags in Folksonomy.

Tagging has its own disadvantages in comparison to the benefits; they are often inaccurate, personal, ambiguous or wrong. Also with the given the amount of freedom to choose tags users tag according their own motivation. Tags can be of wide variety such as subject of the item, ownership, personal or non personal description of the item, location names, purely organizational or completely unrelated.

Location information associated with resources can prove valuable in understanding the content [18]. They can be in the form of tags or geotags. According to Wikipedia geotagging is defined as "The process of adding geographical identification metadata to various media such as photographs, video, websites, SMS messages, or RSS feeds and is a form of latitude and longitude coordinates". Initially geotags were created by user inputs and now they are also be generated by location aware devices and applications. Geotags were initially used with pictures and now it is used with various other media stated above. Tags and geotag together forms the core part of metadata for a resource.

[1] Tag cloud is a visual depiction of user-generated tags or simply the word content of a site, used typically to describe the content of web sites. Tags are usually single words and listed alphabetically with the importance of a tag shown in font size and color.

Every day millions of users from all over the world power the social networking websites such as Flickr[2] with pictures, Twitter[3] with messages, Wikipedia[4] with text, Delicious[5] with social bookmarking, and YouTube[6] with videos and Facebook[7] with volumes of information. If we consider Flickr, on average each day users upload more than 200,000 pictures, thousands of geotags and millions of tags. The spatial dimension makes the geotag data more powerful. In addition to data organization it also supports information retrieval based on location, geotag enabled search engine and creation of bottom-up gazetteers [11]. For our research we choose on geotag pictures for the following reasons:

1. Pictures are inherently related to the real world (Kessler, 2009).
2. Every picture is taken some where on this earth and can be georeferenced. (Crandall, 2009).
3. The picture tags and sometimes picture geotags are generated by users.
4. The relevance of textual tags can be checked against the picture and geotags.
5. Combination of textual tags, picture attributes and geospatial data (geotag) can reveal interesting properties about the picture collections (Crandall, 2009).

The picture metadata often contains irrelevant information in the form of misspellings, vocabulary issues, or wrong geotags. Even though the metadata is imperfect to be used directly but contains human generated contextual knowledge about pictures which provides new opportunities and challenges to make use of it. As part of this research we are interested in assessing the metadata associated with geotag pictures for its quality and usefulness. We choose Flickr as our data source for the research as it is one

[2] www.flickr.com
[3] www.twitter.com
[4] www.wikipedia.com
[5] www.delicious.com
[6] www.youtube.com
[7] www.facebook.com

of the most popular online picture sharing portals with largest collection of geotag pictures. Presently Flickr website has more than 3 billion pictures world wide of which 122 million geotag pictures are available in public domain and approximately 50 millions geotag pictures in private domain (source: Flickr blog).

1.2. Motivation

It has become easy and inexpensive to capture pictures with digital camera or cell phone and upload them to online picture sharing websites with tags, and geotag (metadata). Billions of pictures are shared and viewed on websites such as Flickr which shows the growing importance of sharing information. Since people use metadata to navigate, search and understand the pictures. So it's important that to know the quality and usefulness of metadata and it's not been investigated in depth motivated for this research.

1.3 . Research problem

Navigating these large databases of Flickr for pictures to retrieve accurate place information is difficult. Automated systems also are largely incapable of understanding the semantic content of the photographs [18]. While searching pictures for place, it is not possible to know how many of them would contain recognizable geographic features of that place. The research conducted by (Kessler, 2009) found that on average approximately 20% of total tags are repeated in 80% of pictures. This means remaining 80% of tags are single use tags, which means these tags are either unique and hold useful information or considered as non relevant. This observation raised the question whether this 80-20% phenomenon holds true for placename tags associated with geotag pictures that show recognizable geographic features of a place.

1.4. Research objectives and questions

In this research we would try to understand and analyze the metadata associated with the geotag pictures. Potential issues to explore include:

1. How many geotag pictures show any recognizable geographic features of a place? Is it subjective to user or place?
2. How often do tags do not refer to the place name where the picture was taken? Is it subjective, wrongly related to the picture itself, bulk-uploads or no standards?
3. How often do tags contain hierarchy of place names? Descriptiveness of place and usage of local names.
4. How often does place names linked to the picture do not refer to the geographic content shown in the picture? Is local knowledge required to answer 3 and 4?
5. Ratio between place names tags and other tags? What can we learn from this ratio?
6. How many versions exist for a place name?
7. What categories of tags can be identified (events, place names, external characteristics) using tag cloud.
8. How many new place names can be identified (not registered in geonames)
9. How precise are geotags interims of their location?

1.5. Methodology

The methodology includes using an online survey as a tool to assess the metadata of geotag pictures.. The reason to go with user survey was based on the assumption that “people over the years acquire geographic knowledge and understand the region are in a better position to judge the content of the pictures (Goodchild, 2007) compared to automated process”. Each picture is displayed multiple times (anywhere between 6 and 11 times) to different participants to answer and the response given by majority of participants is considered to judge the picture. The assumption here is that collective

reasoning (crowd sourcing) results in better answers compared to individual reasoning.

The entire process is divided into the three steps:

1. Most interesting 1000 geotag pictures related to the study area from 2008 and 2009 are extracted from online picture sharing website (Flickr) and stored in a database.
2. Online survey form to get answers related to pictures and its metadata
3. Analyze the data and survey results to answer the research questions.

This survey is the first of its kind where it uses combination of tags, location data and picture content in making decision about a picture.

1.6. Outline

In chapter 2, the process of tagging and geotagging and folksonomy are presented. In chapter 3, the noise associated with the metadata of geotag pictures is discussed. In chapter 4, related work and potential use of geotags are presented. Chapter 5 describes design requirements and work flow of user survey. In chapter 6, survey results are analyzed and the research questions are discussed. Finally chapter 7 deals with conclusion of the research and future work.

2. Tagging – Geotagging and Folksonomy

2.1. Web 2.0

A Web 2.0 service allows users to interact with each other as contributors to the website's content in contrast to web 1.0 services where users are limited to the passive viewing of information that is provided to them. Various Web 2.0 services are web-based communities, hosted services, web applications, social-networking sites, video-sharing sites, wikis, blogs and mashups. Wikipedia says "*Web 2.0 is a revolutionary view of the Internet and the social and business uses of advanced technologies rather than the technical aspects of those technologies. The core concept of Web 2.0 is: Use Internet as a platform and leverage network effect to harness the collective intelligence in a cost-effective manner*"

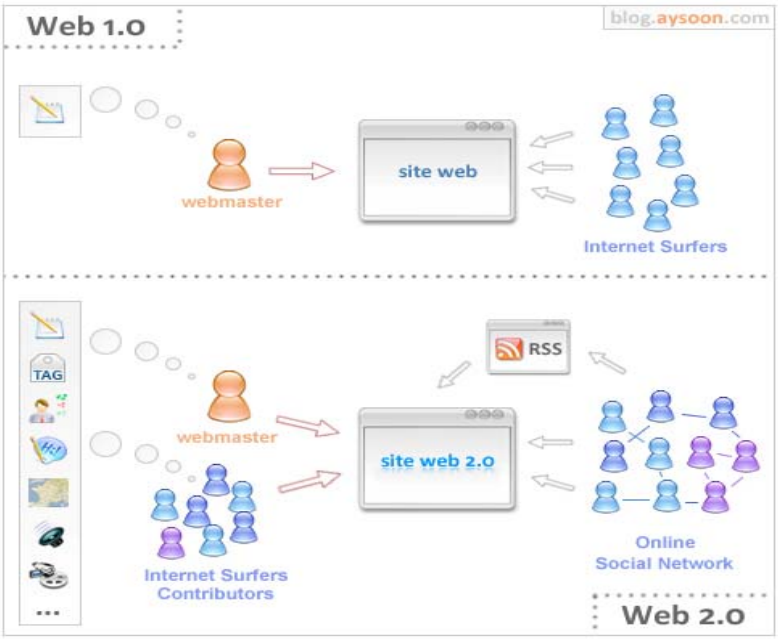

Figure 2.1: Web 1.0 Vs Web 2.0 (Data source: www.sizlopedia.com)

2.2. Tagging

Tags a function of Web 2.0 have become a popular method to annotate content on social web (Intagorn, 2010; Koutrika, 2007) as they allow users to

freely select keywords (tags) from an uncontrolled personal vocabulary to describe the object. Tags become social tags when shared with others users of the website. In social tagging, each tag serves as a link to additional resources tagged the same way by other users. Social tagging systems does not have a predefined taxonomic structure, so they rely on shared and emergent social structures and behaviors, as well as related conceptual and linguistic structures of the user community of a website. Based on this observation the tags in social tagging systems have been termed as folksonomy (Guy, 2006). A taxonomy created by folks (users) is important and emerging concepts of research.

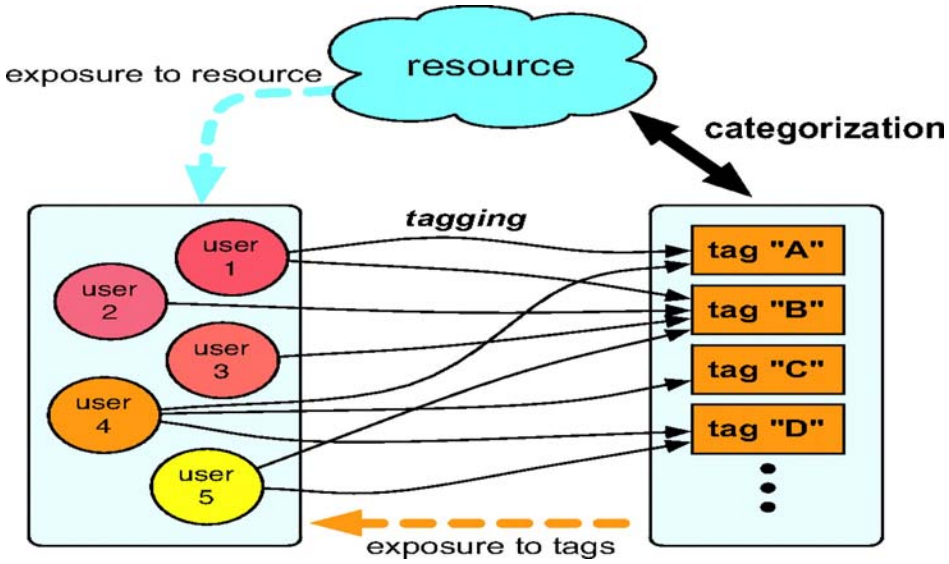

Figure 2.2: Collaborative Tagging System, where different users tag a resource and these tags define the categorization of the resource.

A collaborative social tagging system (Hammond et al. 2005) allows different users to tag the same resources/objects that might result in some differences in describing the resources but in the end should result in meaningful information. The important aspect of collaborative tagging is sharing the total workload of tagging among user community. Most of the social networking websites allow collaborative tagging because it is impossible or would take forever for them to tag its resources. The United States Library of Congress was able to tag 20 million books in 200 yrs compared to 22 million books

tagged in 3 years on www.librarything.com. It clearly shows that collaborative can achieve targets that seem impossible. The tag quality of the later is lower than the former but in long run; it could achieve the same quality. In addition to keywords, users can now attach geospatial metadata to various media in the form of geographic coordinates, called as geotag. The latitude and longitude coordinates are unique, universal and language independent, which makes it easy to use it. The notion of defining data geographically has emerged as the latest trend among the most the popular social networking websites. Various social networking websites allow users to geotag the resources online.

The following is a list of popular websites that allow users to tag the resources:

- Del.icio.us (www.del.icio.us) is a social bookmarking site that allows users to save and tag web pages and resources.
- CiteULike (www.citeulike.org) is an online service to organize academic publications that allows users to tag academic papers and books.
- *Twitter (www.twitter.com) is a real-time information network that allows users all around the world who share and discover what's happening around. User can publish their geotag while twittering.*
- Flickr (www.flickr.com) is a photo-sharing service that allows users to store, tag and geotag their personal photos, as well as maintain a network of contacts and tag others photos.
- YouTube (www.youtube.com) is a video sharing system that allows users to upload video content and describe it with tags.
- Last.fm (www.last.fm) is a music information database that allows members to tag artists, albums, and songs
- Technorati (www.technorati.com) is a weblog aggregator and search tool that allows blog authors to tag their posts.

- Four Square (www.foursquare.com) is a cross between a friend-finder, a social city-guide and a game that rewards you for doing interesting things based on the existing location data sent from mobile phone.

2.3. Methods of geotagging

Assigning place names to the objects was the earliest way of geo-referencing a resource. [longley, Goodchild, Maguire & Rhind, 2005]. Most of the online picture portals used this method of manually adding the placename tag in early stages of geotagging pictures and later developed better methods to geotag. Presently a picture can be geotagged by three ways:

(1) Automatic digital cameras with GPS: Some digital cameras and camera phones have built-in or linked GPS device. The picture taken by these digital cameras include an EXIF (Exchangeable Image File) header with latitude, longitude, altitude and many other parameters pertaining to the acquisition of that photo. This is the easiest and precise method of geocoding an image if it has a good satellite signal at the time of taking the photo.

(2) Digital camera synchronized with a separate GPS: Most of the digital cameras sold today do not have a built-in GPS receiver; however, an external location-aware device such as a hand-held GPS logger used with these digital cameras for geocoding. With the help of the software the timestamps made by the camera are synchronized with the timestamps recorded in GPS logger and based on the timestamps the corresponding coordinates stored in the GPS logger are added to the EXIF information of the photo. Most important factor in this process is the clocks in these devices must have same time for proper synchronization.

(3) Manual geocoding: Location information added to photos manually by specifying the coordinates or by selecting a location on a map while uploading

the pictures on the internet. The precision and accuracy of geotag in this method depends on the user and the mapping tools of the websites.

2.4. Geotag picture sharing websites

There are number of websites that offer services to share pictures online but only few of them provide geotag function. The most prominent among them are, Google's Picasa, Yahoo's Flickr, Google's Panoramio, SmugMug, Locr, and Everytrail.

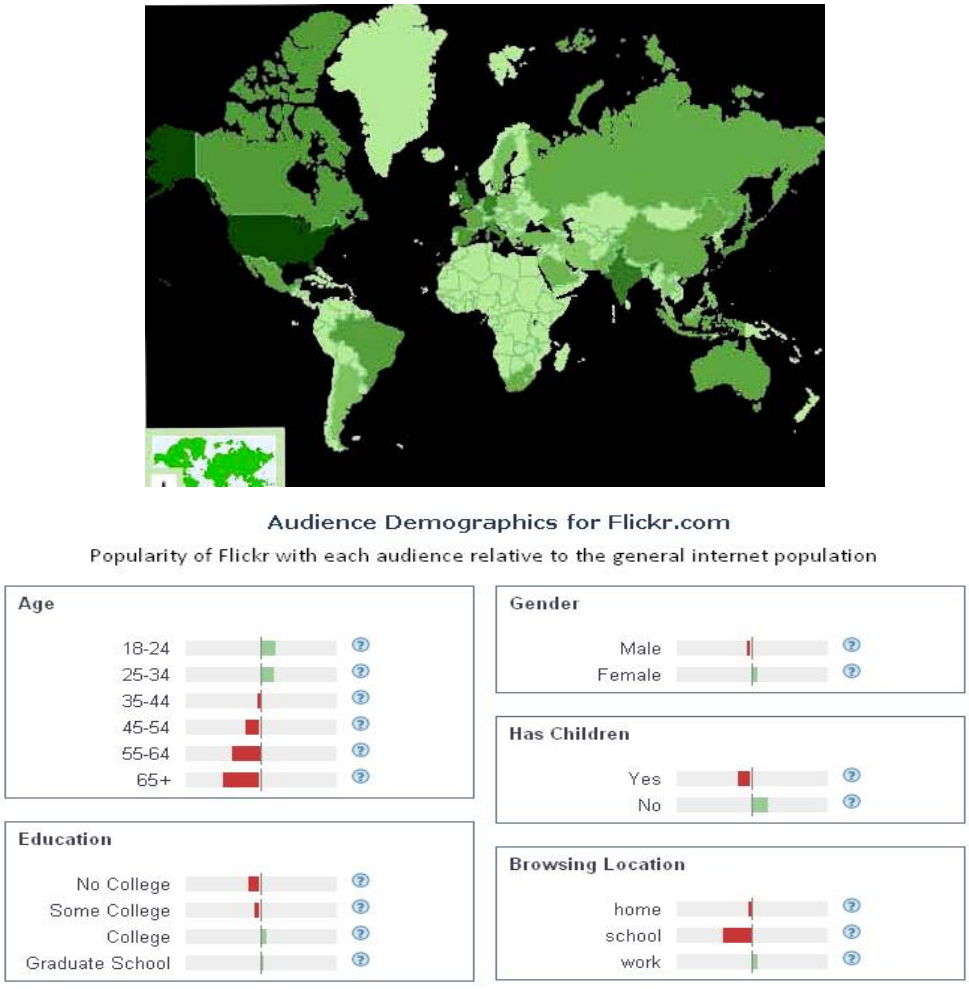

Figure 2.3: Visitors by country [Top 5: USA: 31.7 %, India 6.3%, UK 5.7%, Germany 5% & Italy 3.5%] and user demographics

A Geotag adds spatial dimension (latitude and longitude) to the picture, which is stored with picture file and cannot be seen explicitly. Only geotag systems can recognize this information. It brought a revolution on how pictures are shared and viewed both online and offline. The online photo-sharing sites that offer geotag function to users provide varying degrees of support to pictures that do not have geotag information in EXIF data. Some sites allow users to tag to precise location others to the city or neighborhood where the pictures were taken.

2.4.1. Flickr website

Flickr is the most popular and a free online photo storage and management website. It allows users to organize photos into albums, tag them with descriptive keywords and location coordinates

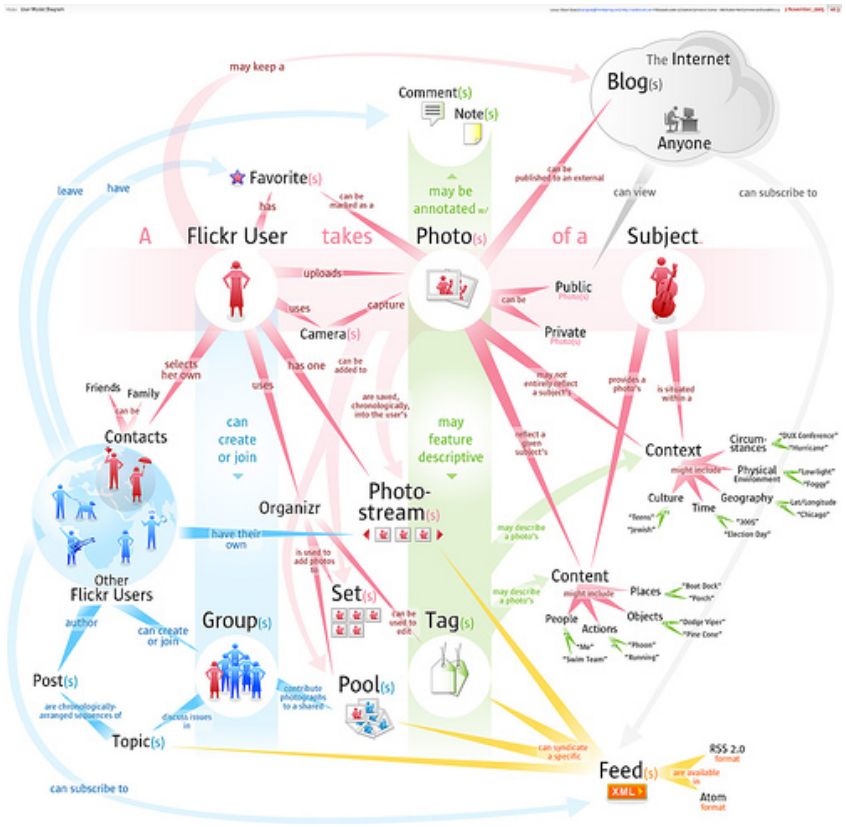

Figure 2.4: Flickr user model
(Data source: http://www.flickr.com/photos/bryce/58299511/in/photostream/)

Flickr user model (Figure 2.4) provides information about organization and services of Flickr in very elaborate way. Free users can to store up to 100MB of images per month and paid users have unlimited storage.

2.5. Folksonomy

In Web 2.0, the roles of users have changed from information consumers to both consumers, producers and contributors (Peters & Stock, 2007). The concept of users creating and aggregating their own metadata is gaining ground on the internet (Speller, 2007). Folksonomy defined as community based metadata and a means of establishing semantics. According to Wikipedia, it is defined as *"internet based system of classification derived from the practice and method of collaboratively creating and managing tags to annotate and categorize content. This practice is also known as collaborative tagging, social classification, social indexing, and social tagging. Folksonomy is a blend of folk and taxonomy"*. Folksonomies have emerged from the social web applications that use tagging (Gruber, 2005). He also said that such tagging systems attract many users, as they are easy to use, has not limit in terms of number of tags and there is no wrong answer.

Folksonomies include everyone's vocabulary; reflect everyone's needs without cultural, social, or political bias which in contrast to traditional taxonomy of controlled vocabularies and hierarchical nature. Since it is not an expert developed and controlled vocabulary, so they are unsystematic, inconsistent and does not follow any standards. There are no wrong or right tags in folksonomies. In addition, users tag the pictures based on their personal experience and interest that results in different viewpoints/opinions on same subject. Folksonomies provides a chance to observe how users tag web resources (user behavior) as well as emergence of untraditional categories. This kind of approach also contributes to metanoise that consists of linguistic errors, irrelevant and inaccurate information. Compared to categories or ontology-based systems, these tags result in unstructured

knowledge, as they have no a-priori semantics. However, this unstructured nature of tags helps the usage. It also observed that tags are probably easier to enter than picking categories from ontology. In addition, tags allow for greater flexibility and variation and tags can naturally evolve to reflect emergent properties of the data.

We believe that this social metadata with tags linked with geographic data (geotag) provides a valuable source of information for learning about places. Acquiring accurate geospatial knowledge presents several challenges (Intagorn, 2010), which are discussed in detail in next chapter.

3. Noise Aspect of Geotag Pictures

Noise or metanoise is defined as inaccurate or irrelevant or insignificant metadata. This is particularly prevalent in systems not based on a controlled vocabulary, such as certain folksonomies (Wikipedia, 2010). Noise in this context can be defined as “the presence of which can confuse or divert attention from relevant information; data efficiency is enhanced as the ratio of information to noise increases”. Why should we care about the noise? As the data at our disposal is user generated and does not follow any set of rules.

The applications/websites that depend on user contributions, the quality criteria’s (accuracy, completeness, consistency and lineage) are not checked before they are posted on the websites and the contributors do not provide any guarantee of its veracity (Kessler, 2008). It is a major concern to directly incorporate such data in applications that needs high quality data (Maue, 2007). As the number of tags continues to grow in these tagging systems and people start to use the tags for purposes beyond the intent of the tag contributors. It is important that we know the quality of the tags and understand the implications of tag quality to various applications that use it. Many of the data quality concepts and methods developed in prior researches were relevant and applicable to tag quality but the unique social characteristics of the tagging and geotagging systems warrant a dedicated in-depth study on the quality of tags.

In this chapter we identified various kinds of noise that could be associated with the metadata of geotag pictures and also ways to measure them in this context.

3.1. Bulk uploading

During the process of bulk uploading all the pictures could be geotagged to one location even though they may not represent the same location. Same

applies to concurrent tagging, where pictures get associated with a tag that doesn't apply to it. Most of the photos sharing websites allow bulk uploading and concurrent tagging to make the process easy for the users but this in-turn could create lot of noise.

3.2. Picture location

Theoretically every picture taken can be tagged to a location but the issue is to tag to the right location that it represents. There is dilemma in terms of geotagging a picture to the location from where it was taken or to the location of the object that it represents. For example the picture (R) below can be tagged to Eiffel Tower location or to the photographer's location. If taken by gps enable camera then it would geotag to the photographer's location which is approx 1.0 km from the Eiffel tower other wise mostly likely to be tagged to Eiffel tower location. This has implications on search and retrieval of pictures based on object location.

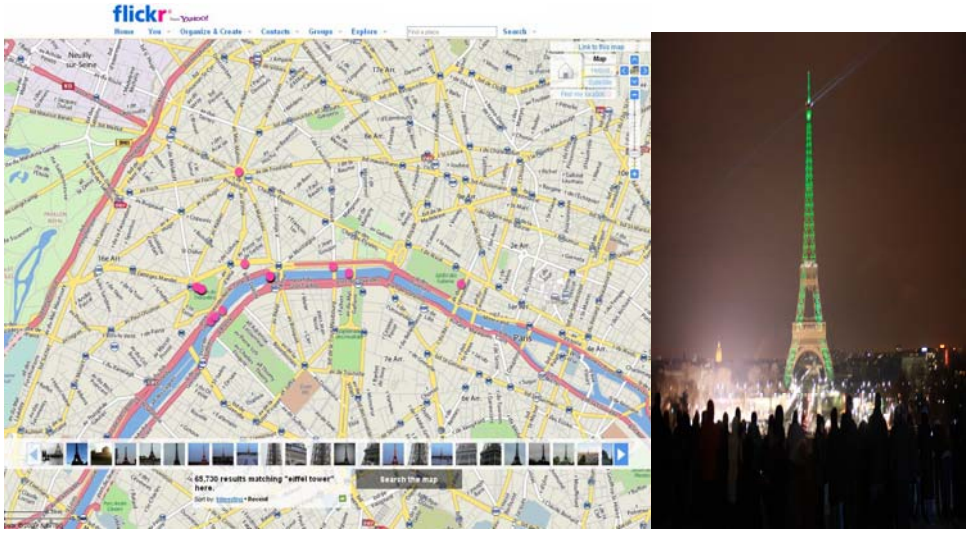

Figure 3.1: (L) Search in Flickr (R) Eiffel tower taken from Trocadero

3.3. Manual geotags

There are still large numbers of users who use non-gps cameras and only way for them to geotag their photos is by manual process. In the initial stages of geotagging, a user had limited options, he could only geotag a picture to a

city not to the exact location in the city or some times only major cities were listed so users has to chose the nearest major city as its location (Flickr Blog). Presently the Flickr gives an option to search for a place name on a map which is in their database or explore the location on a map to geotag a picture. According to Flickr blog there have been numerous instances where the place name that users were looking was not found. According to Dan Catt (geo-expert working for Flickr), there were some problems in getting accurate place name based on the latitude and longitude coordinates of the picture for certain parts of the world (Flickr Blog). Flickr offers the best assessment of where the picture was taken based on the provided information by the user and it's up to the users to fix the location if it not accurate. It clearly shows that photos geotagged earlier have more error in terms of their location accuracy compared to recent additions. The involvement of human element in the process of geotagging can be a source of error.

3.4. Spam

As tagging systems are gaining in popularity, they become more susceptible to tag spam. Misleading tags are generated in order to increase the visibility of some resources or simply to confuse users. This type of tag collection is called "metacrap" (Doctorow 2001).

3.5. Moral hazard

Contributors could geotag (or tag) to imprecise location (or information) due to laziness (Maue, 2007). Also they may have certain personal meaning in entering tags not understood by others.

3.6. Absence of controlled vocabulary

None of the social websites have control on the vocabulary used by users for tagging a resource. According to (Guy & Tonkin, 2006) most users don't give much thought about tagging a resource. Bad or "sloppy" tags form a significant number in folksonomies. When tested against multilingual

dictionary software they found 40% of Flickr tags and 28% of Delicious tags have these problems.

3.6.1. Synonyms and homonyms:

Tagging doesn't follow any format and doesn't control synonyms and homonyms (Lee, 2008). This result in tags that have the same meaning or mean the same, like "NYC" and "New York City", both refer to New York City in USA. Searching for objects tagging "NYC" would not contain objects tagged "New York City" and vice versa. Singular vs. Plural is often a problem; we can find 6 pairs of words with this issue, which is 8% of total number of popular tags listed in Figure 3.2. Social websites such as Flickr, twitter, you tube have users from all over the world. There is a difference in some of the words between British and American English (e.g. humour, colour in British English is same as humor and color in American English). Many users from non-english speaking countries tag resources in their own language like "Germany" is tagged "Deutschland" or "Alemania". This leads to the problems of trans-language-synonymy.

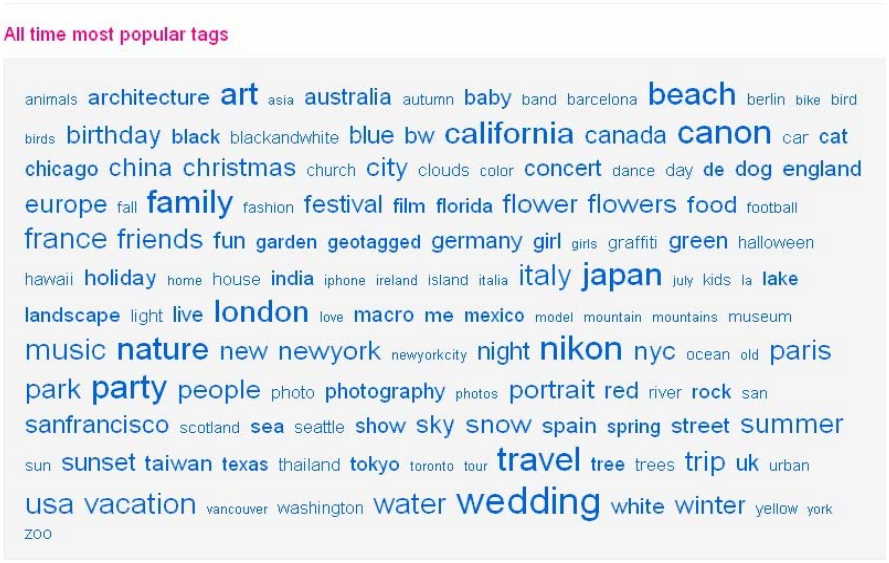

Figure 3.2: All time most popular tags from Flickr

Homonym (same word, different meaning) represents a different but related problem to synonyms (speller, 2007). The presence of homonyms in the system means that search precision is reduced.

3.6.2. Ambiguity:

Some tags have more than one meaning causing ambiguity (Weinberger, 2008; Mathes 2004; Golder and Huberman, 2006). Ambiguity in tags can be in terms of words (e.g. ‘cologne’ word can be a city name or perfume/scent), geographic (e.g. 'Arlington' can be city in Texas or county in Virginia), temporal (e.g. 'new year' can be 2009 or 2010 or any other year), language (e.g. 'piece' in French means room, where as in English it means a part of a whole unit), and general place name (e.g. a picture of Muenster tagged as Europe). Even thought Muenster is in Europe, the coverage area of Muenster is very small when compared to Europe. In the Figure 3.2 “New York” could be New York City or New York State. “de” could refer to Germany (German users) or Delaware State (for USA users).

In addition to these noises, contributors (users) can create more noise in tags if they don’t adhere to the tag format recommended by the tagging systems. In case of Flickr, it has set of rules (details in 4.2) that one needs to follow while tagging.

We analyzed the most popular tags on Flickr website based on the format of research studies mentioned in Chapter 5. Out of 145 popular tags (Figure 3.2), 64 tags (44%) describe **place names** of which 41 (28%) are location specific (India, Germany, Spain, USA, Paris,..) and 23 are general place names (garden, park, city, urban, zoo), 16 tags (11%) describe an **events** (birthday, Christmas, concert, trip, party), 8 tags (6%) are related to a **time** (June, July, spring, summer), 47 tags (32%) describe the **picture content** (art, animals, people, blue, car, clouds, trees), 7 tags (5%) about **camera**

(Cannon, Nikon)and colors (BW, black & white) and remaining 3 tags (2%) cant be associated with above categories (photo, San).

We further analyzed these tags for the tagging behavior of users: We found the following tagging habits of users:

- Space free tagging: different words are concatenated into one word (newyorkcity, sanfrancisco, balckandwhite).
- Singular and Plural tags: sets of words of which one is plural form of other word (bird-birds, tree-trees, photo-photos).
- Vertical sentence tagging: if the user doesn't use quotes while entering multiple words or a sentence as a tag then Flickr considers each word as separate tag (New York is treated as two tags New and York).
- Abbreviation: tagging pictures with fill and short names (Germany – DE, "New York"- nyc).
- Synonyms: different users tagging a picture with different words that means the same (house – home,).
- Incomplete tags: which don't make any sense (san, bw).
- Vocabulary issues: New York here represents city or state (Italy- Italia, New York City – New York)

All the above mentioned noises contribute to 20% of total all time popular tags.

3.7. Measurement of noise

Noise as we discussed above is inherent with the applications based on user contributions. As part of this research we are interested to measure and asses noise at the tag level and tag collection level. The primary focus will be place name tags at both levels.

At tag level we are interested in:

1. Typos in a tag
2. Polysemous words
3. Repetition and redundant words
4. Irrelevant tag

5. Imprecise geotag
6. Ambiguous words

At tag collection level, we are interested in

1. Number of synonyms and stemmed words
2. Number of homonymous words
3. Characteristics of tag cloud
4. Probabilistic distribution of tags
5. Number of acronyms
6. Number of spam words

4. Related work

In this chapter we review both completed and ongoing research in the areas of our research. The focus is on works that deal with assessment of metadata associated with geotag resources online. Many researchers have studied tags and folksonomy associated with resources and use of geotags in addition to tags to solve the problems associated with tagging. To the best of our knowledge no in-depth research was conducted to study the quality of metadata associated with geotag photos and assessment photos that represent geographic space of a location among the available photos.

4.1. Tag quality

Tags are a result of contributor's action and tag quality according to (Carmagnola, 2007) depends on the following factors:

1. Interaction level: Contributors have to explicitly perform this action, which requires time and effort. So contributor's interaction level is directly related to the tagging quality.
2. Organization level: how best the contributors can organize the pictures, both personal and professional way in order to better visualize, store and retrieve them.
3. Interest in the content: contributor's interest in the picture content helps to assign meaningful tags to the resources. A knowledgeable contributor is more likely to use specific terms than a less knowledgeable contributor (Golder and Huberman, 2006)

Another important issue that influences tag quality is about understanding the motivation of users. This provides insights into tagging systems, according to Koerner (2008). He thinks there are two groups of people who do tagging, categorizers and describers. Categorizers like to tag their resources with their vocabulary based on mental model and use less number of tags. On other hand describers annotate the content as much as possible so it is easy

for retrieval. They often use synonyms. His study of data from Del.icio.us, Flickr, ESP game, Bibsonomy found that if number of tags were used only once then the person is describer and growth of tagging vocabulary increases with contributions from describers.

4.2. Studies on Flickr data

Flick being the most popular online photo sharing website, attracts various researchers to study the user generated content uploaded to their website. We found studies related to tag classification and tagging habits. Tags that are found on Flickr website tend to fall into the following categories as defined by (Maala et al., 2007) and (Wingnet, 2006):

- Place: the location can be described at very different levels of granularity. At the largest level of granularity, the continent, the country, the region, the city, mountain ranges are found frequently. At the smallest level of granularity, there can be a description of a room or a piece of furniture, bed and chair. The rest are in between these two levels.
- Time: the time can also be described at different levels of granularity. The year, season and the month are frequently used. The exact day is much less frequent. Some times about the day (sunrise, sunset).
- Event: holydays (Christmas, Halloween), birthdays, weddings, concerts, etc.
- Name: people names (Emma, Jean), nicknames.
- Picture description: describing the content of the picture (building, city, pets)
- Camera details: many tags indicate the make or the model of the camera (Nokia, Canon), the colors (black & white) and artistic judgments on the photo.

A research by (Maala et al., 2007) observed the following tagging habits of Flickr users:

- Very few tags: some of the photos have very less or no tags.

- Sentence tag: users can use quotes to use a full sentence as a tag. For example “The Best scenic view, must see”. If no quotes are use then Flickr interprets each word as separate tag. (Picture).
- Too many tags: contrary to earlier observation, some pictures have too many tags. Flickr allows maximum of 75 tags for each picture.
- Nonsense tags: these tags are something not understandable by humans or computers. (e.g. $$$$Tsk, 16s)
- Non related tags: these tags don’t correspond to the content of the photos.
- Space free tags: users write whole sentence by concatenating words together. For example “TheBestscenicview”.
- Collective tags: Flickr allows bulk uploads, which allows tagging several pictures concurrently. Therefore sometimes pictures get associated with a tag that doesn’t apply to it.
- Personal tags: are important to the contributor but not to the wider audience.

4.3. Social Behavior:

Observing evolution of tags helps to understand the behavior of the participating user community. One of the ways to observe the social behavior of tagging community is by visualizing the popular pictures and tags associated with it. At present visualizations use only tags associated with pictures to display the tagging behavior and hopefully in future if they would also include photos and location data. One such step in this direction is a research by (Micah al et. yahoo research team, 2007) to devised a methodology to visualize over the time the interesting tags among the total number of tags uploaded to the Flickr website. They came up with a new algorithms and data structures to deal with millions of tags and photos uploaded each week. This visualization tool helps to discover the behavior of users over the time or to explore the evolution of community interests. It is made up of two interchangeable metaphors the ‘river’ and the ‘waterfall’. In the river metaphor, tags appear to travel from right to left of the screen slowly

and disappear. The font size of the tag is proportional to the intensity of its interestingness. As each tag 'flows' from right to left, it displays one photo from Flickr with this tag. If the tag is 'caught' using the mouse pointer during its journey from right to left, it displays more photos with this tag. In the waterfall metaphor, the screen is divided into left and right halves. The top 8 most interesting tags are displayed in 8 rows in the left half, with font sizes proportional to the intensities of their interestingness. The tags change as days go by. The right half of the screen displays the photos corresponding to each tag. If a tag persists for more than one consecutive day then more photos are added to its row. These metaphors are useful in understanding the evolution of tags in a user community and also to visualize the photos associated with them.

4.4. Semantics and Ontology

With large number of tags generated by users, understanding semantics of these tags and deriving knowledge out of tags is an interesting topic for research. Research was conducted at Yahoo Research Center on how to automatically determine the spatial and temporal patterns by extracting semantics from Flickr tags (Rattenbury, 2007). In this research geotag pictures from San Francisco, USA and its metadata (location and time information) were extracted from Flickr. This study aims to improve image search through inferred query semantics; automatic creation of place and event gazetteer data (used to improve web search, for example); and automatic association of missing location/time metadata to photos, or other resources, based on tags or caption text. Methodology is based on, first to determine the semantics of set of tags they have collected. Second, to distribute tags over some dimension (location or time) third, to assume that there is a relation between the semantics extracted from tags to the dimension over which the tag's usage is distributed. Tags that correspond to events and places help to detect bursts of usage in space or time – i.e., if the tag demonstrates a strong spatial burst of usage then it is likely a place

related and if it demonstrates a strong temporal burst of usage then it is likely an event related. The then tested two standard burst detection methods Naïve and Spatial Scan to see if they work with the data. Naive Scan method is used to detect important query terms in web query logs [4] and Spatial Scan method is used by epidemiologists to detect disease outbreaks [3]. The primary issue with these methods is they do not perform well when the data is sparse and contains multiple bursts. So they introduced a new method to handle the issue of multiple bursts, called Scale-structure Identification (or SSI). This method measures how similar the data is to a single cluster at multiple scales. SSI works by: (1) clustering the usage distribution for a tag at multiple scales; (2) measuring the dispersion of usage occurrences among the clusters by calculating the information entropy; and (3) summing the entropy calculations at each scale to produce a single score. The experiment showed that SSI works better than the other two. Although the research was conducted using pictures it would not only be helpful to applications involving pictures but any other geotagged media.

Research by Schmitz (2006) from Yahoo Research team to induce Ontology from Flickr tags using the statistical model for sub-sumption derived from the co-occurrence of tags, where a condition is used to define one term subsuming another. In this approach he considered a tag x subsumes another tag y if the probability of x occurring given by y (the probability of finding tag x in documents tagged with y) is above a certain threshold and probability of y occurring given x is below the same threshold, he explained this relation using the following equations

P (x|y >= t) and P (y|x < t),
Dx >= Dmin, Dy >= Dmin,
Ux >= Umin, Uy >= Umin
Where:
t is the co-occurrence threshold,

Dx is the number of documents in which term **x** occurs, and must be greater than a minimum value **Dmin**, and

Ux is the number of users that use **x** in at least one image annotation, and must be greater than a minimum value **Umin**.

He used this method to develop what he called revised, probabilistic model. The subsumption model is applied on sets of tags acquired from Flickr to build a graph of possible parent-child relationship.

4.5. Gazetteer

The existing gazetteers are developed by administrative authorities and are directories for named places. The core components of a gazetteer are place name, the type of place it represents and a geographic footprint representing its location or extent. Various studies [Herrich and Luedecke], [Goldberg et al.] were carried about using the ever growing user generated data to create gazetteers. Kessler et al (2009) proposed a bottom-up approach for gazetteer building based on geotagged pictures from web. These gazetteers would provide additional information which is missing from the traditional ones.

4.6. Automated filtering

Automatic filtering of non-place name tags associated with Flickr pictures was proposed by Rattenbury and Naaman (2009). This process automatically detects tags associated with places on Flickr by analyzing the spatial distribution of the coordinates of the photos associated with that tag. This approach too has some drawbacks in terms of filtering ambiguous and idiosyncratic names.

5. Online Survey

This chapter provides an overview of data collection and online survey process.

5.1. Data Collection

Data for the study area (Muenster) was collected from Flickr website using Application Programming Interfaces (API) provided by Flickr. We used two API's flickr.place.find and flickr.photos.search. First API(flickr.place.find) was used to get the place_ID of Muenster, which was used in the second API (flickr.photos.search) to extract 1000 most interesting geotag pictures available in public domain for year 2008 and 2009. The following maps shows the place_ID (purple line) and geolocations of the 1000 pictures.

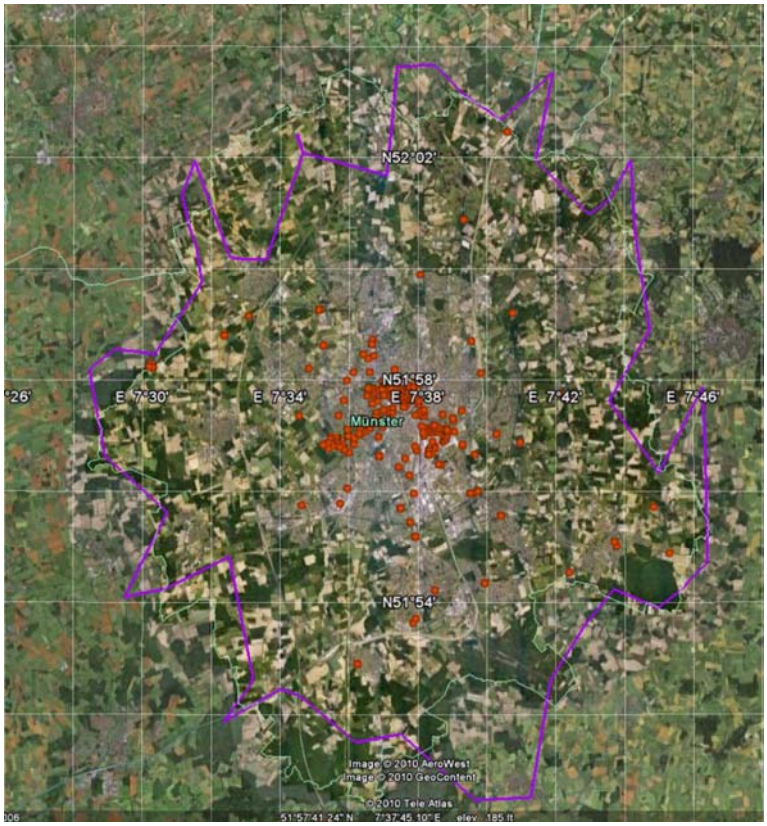

Figure 5.1: Study area map with geolocation of picture data

The online survey was created using PHP, HTML and MySQL .

5.2. Introduction screen

Provides brief introduction about the survey and option to select one of the two surveys, Muenster survey or worldwide survey. Muenster survey is implemented for this project for which we extracted 1000 most interesting pictures from year 2008 and 2009 of City of Muenster, North Rhine-Westphalia, Germany from Flickr website. Worldwide survey is not part of this project but implemented simultaneously as a future extension of this work. In addition to Muenster survey users can select worldwide survey for pictures from their choice of city.

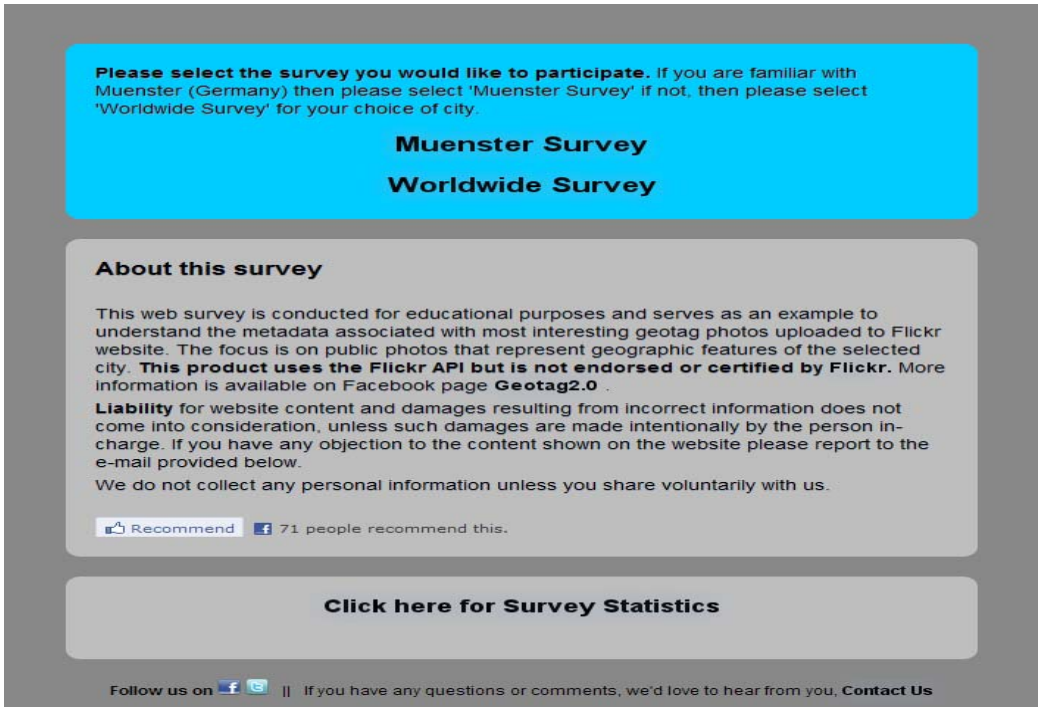

Figure 5.2: Introduction screen

One round of survey involves 20 pictures and each picture has up to four questions, which are:

1. Identify if the picture represents recognizable geographic feature of the selected place. Assuming that the picture is seen for the first time.

2. Familiarity of picture location and contents
3. Selecting only place names tags in the order of relevance (first local names, followed by city, state, country and continent).
4. Identifying if the picture location shown on the map represents the contents of the picture.

5.3. Welcome Screen

In this section, user has to answer three questions about their familiarity with geography subject, computer usage and selected location. The user's identity is saved in the form of cookie information for 180 days so when the users return back to the survey, they skip the welcome screen and directly proceed to first question (Figure 5.4). This information is used to program the survey in such a way that same pictures are repeated to the users who have answered them.

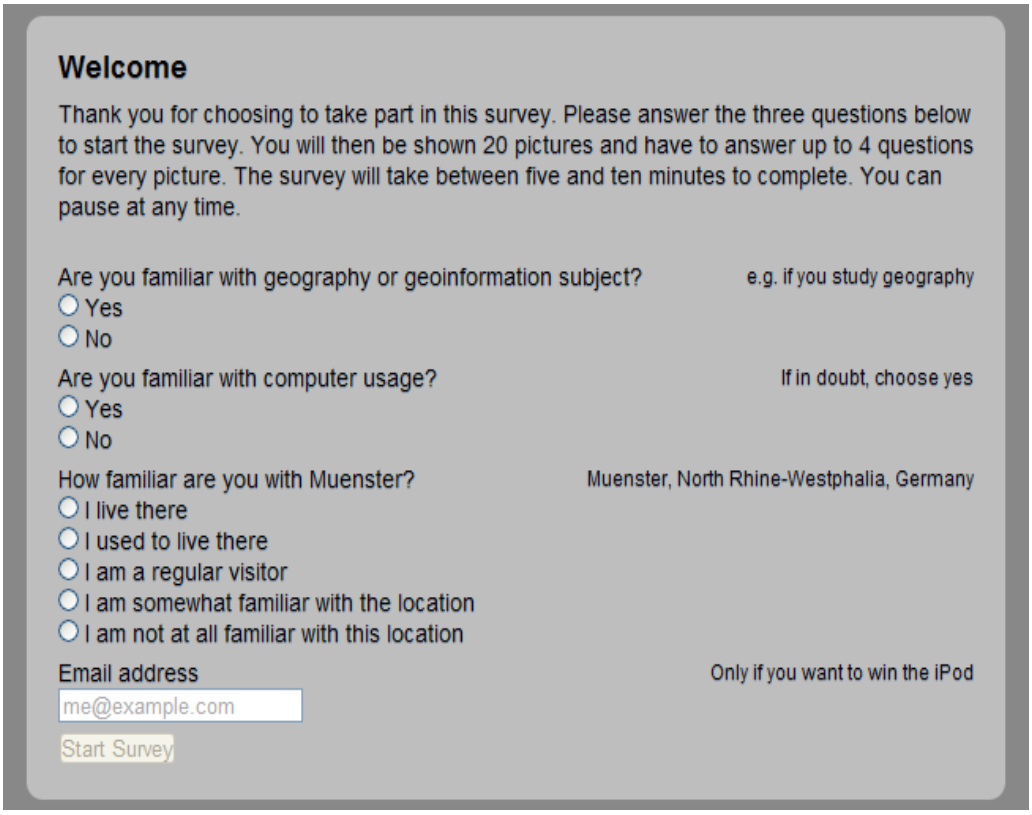

Figure 5.3: Welcome screen

5.4. Picture Selection and familiarity:

In this section the user has to select if the picture shows any recognizable geographic feature(s) of the selected place or not. If the user selects 'NO' then a new picture from the database is fetched and displayed. If user selects 'YES' then it will take to next screen (Figure 5.5) where he/she has to answer his/her familiarity with the location and contents shown in the picture.

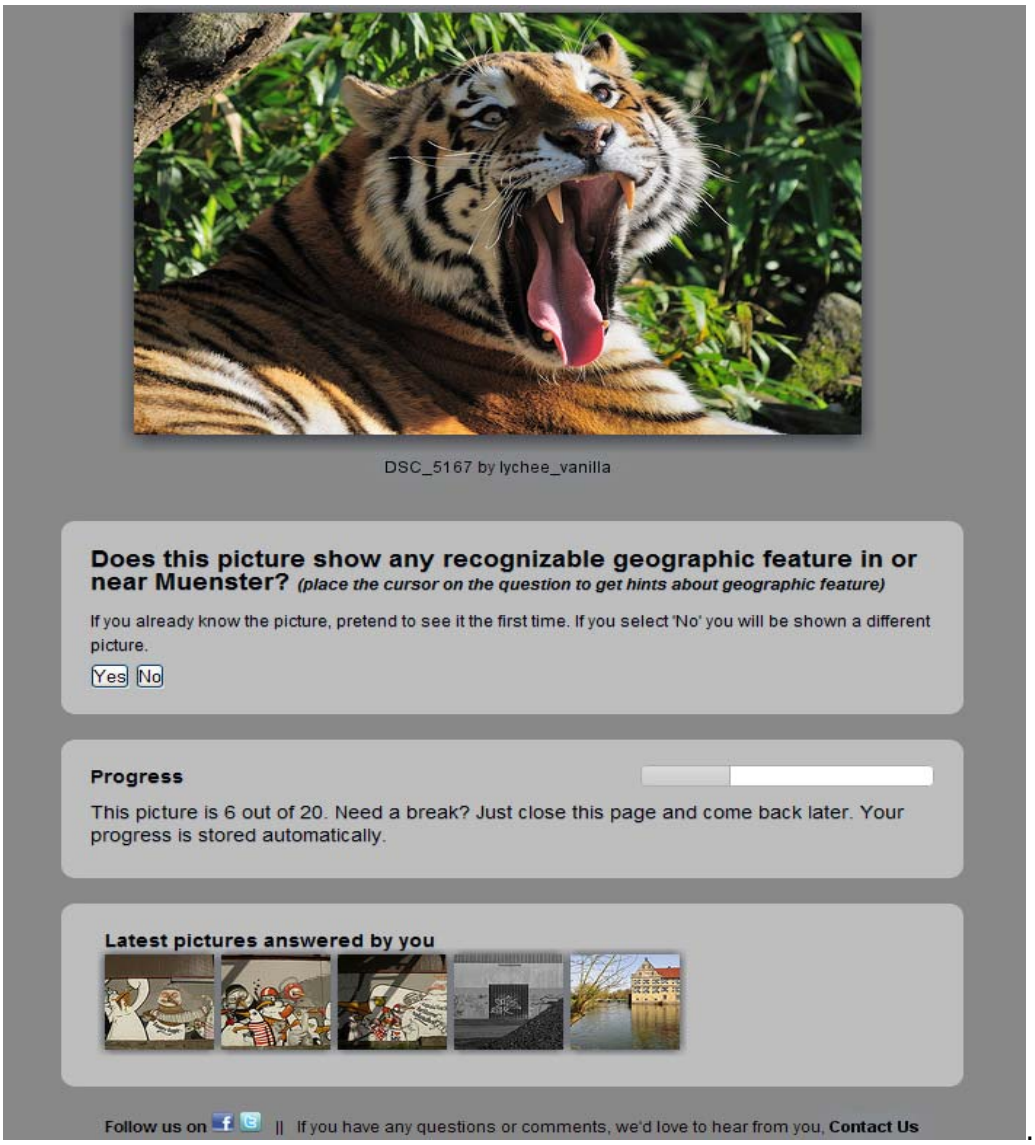

Figure 5.4: Picture selection

By placing the cursor on the question provides the definition of ‘geographic feature’ used in the context of the survey to help the user to answer the

question “Geographic feature in this context is any picture that shows streets, buildings, parks, water bodies, open spaces and monuments that can be identified with Muenster. Indoor photos are 'OK' only if taken inside churches, shopping centers, train stations, airports and museums.

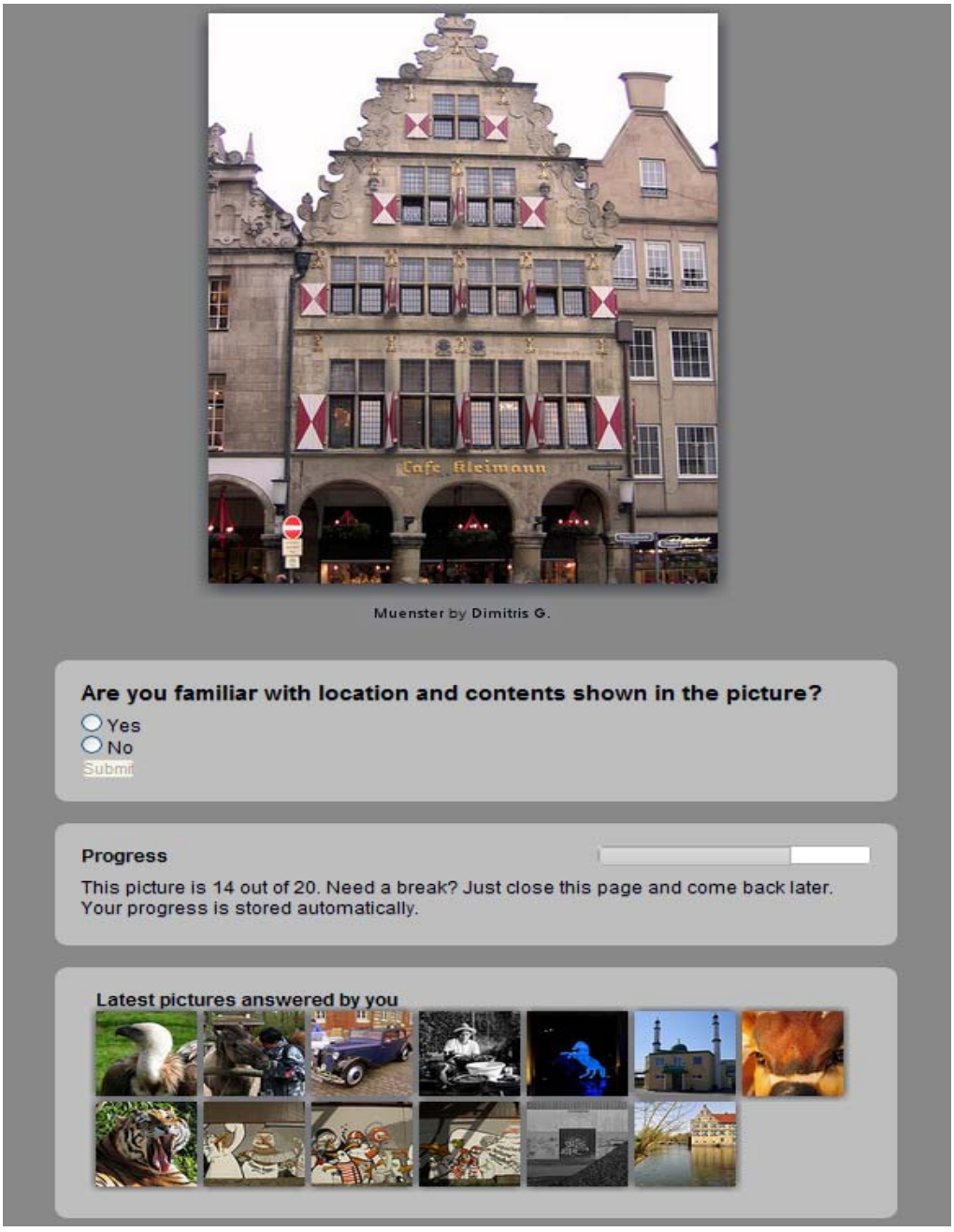

Figure 5.5: Answer familiarity with picture contents

5.5. Tag Selection

In this section all tags associated with the photo (created both by the owner of the picture and other users of Flickr website) are displayed on the left side of the screen. The user has to select only place name tags by dragging and dropping on the right side of the screen that says (Figure 5.6) “Drop here”. User has the option to rearrange the tags in the order of the most relevant on top to least relevant at the bottom by dragging up and down. Before clicking the submit button. The user can view the demo of this process by clicking the “video demo” link on the page.

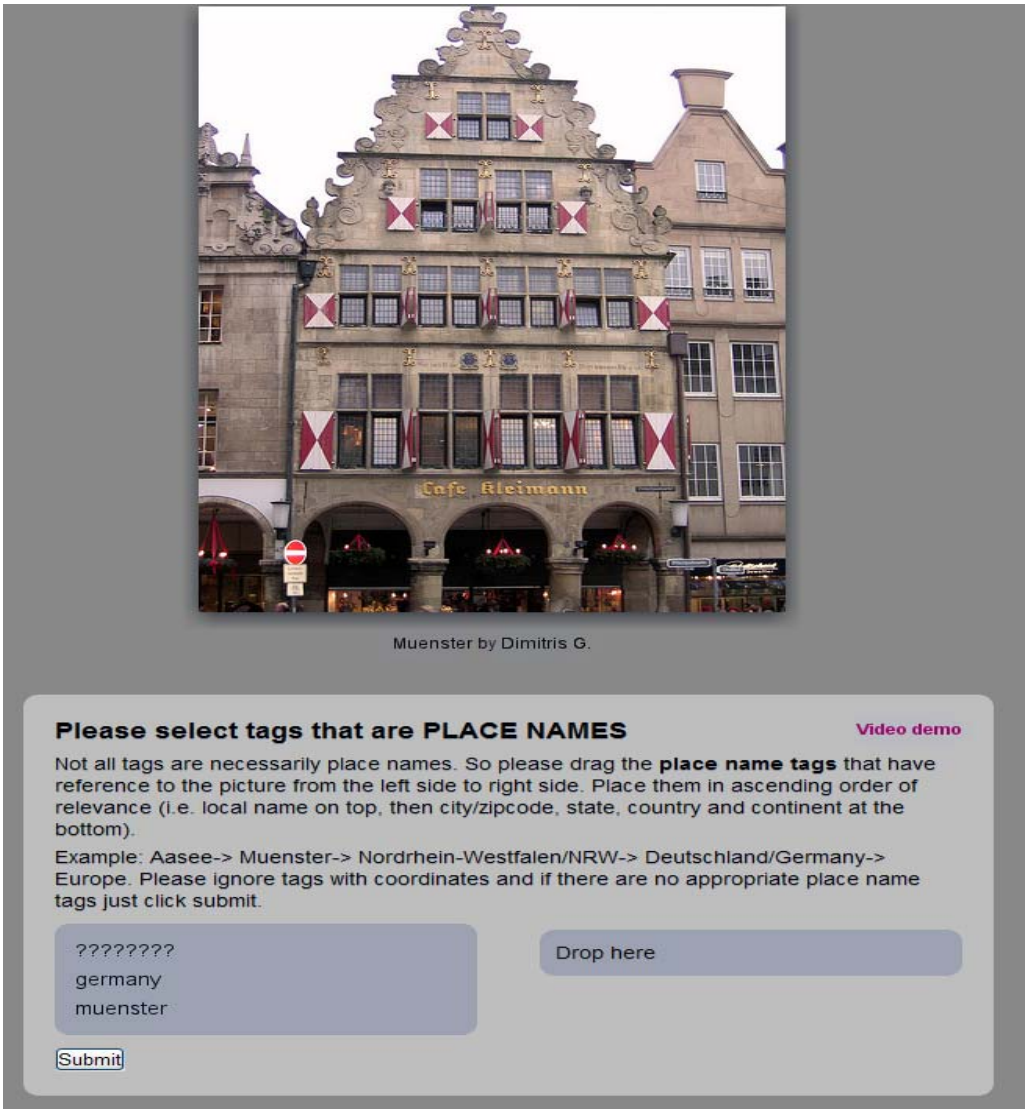

Figure 5.6 Select place name tags

5.6. Identifying Picture location

Once the place name tags are selected then the next task for the user is to identify the location of the picture on the map. A map is shown with picture location based on the geotag information of picture. The user has to select one of the four options according to his/her opinion describes the best possible position of the picture.

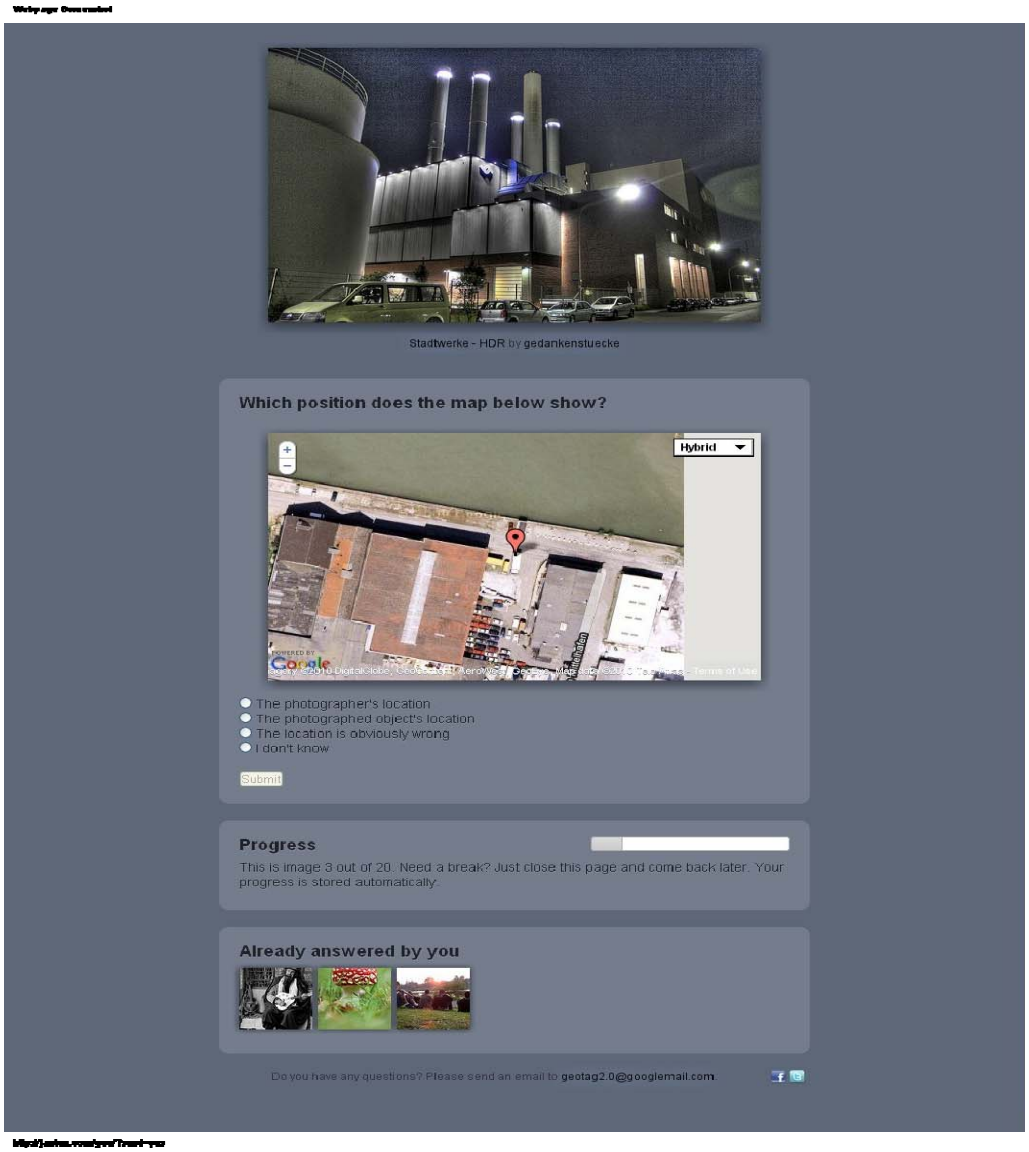

Figure 5.7: Identify picture location

Once the user answers this question then a new picture is shown and process described above repeats until 20 of them are answered. The user has the option to quit the survey at any point of time and continue later to finish answering 20 pictures. We keep track of each user who started the survey and photos that were answered by him/her during a period of 180 days and are displayed at the bottom of the screen for 180 days. There is no limit in terms of number of times or number of pictures a user can answer the survey. The user can check his progress in the section below the questions.

5.7. End of survey:

This screen appears when 20 pictures are answered by a user. The user can either close the survey or continue with another round of 20 photos.

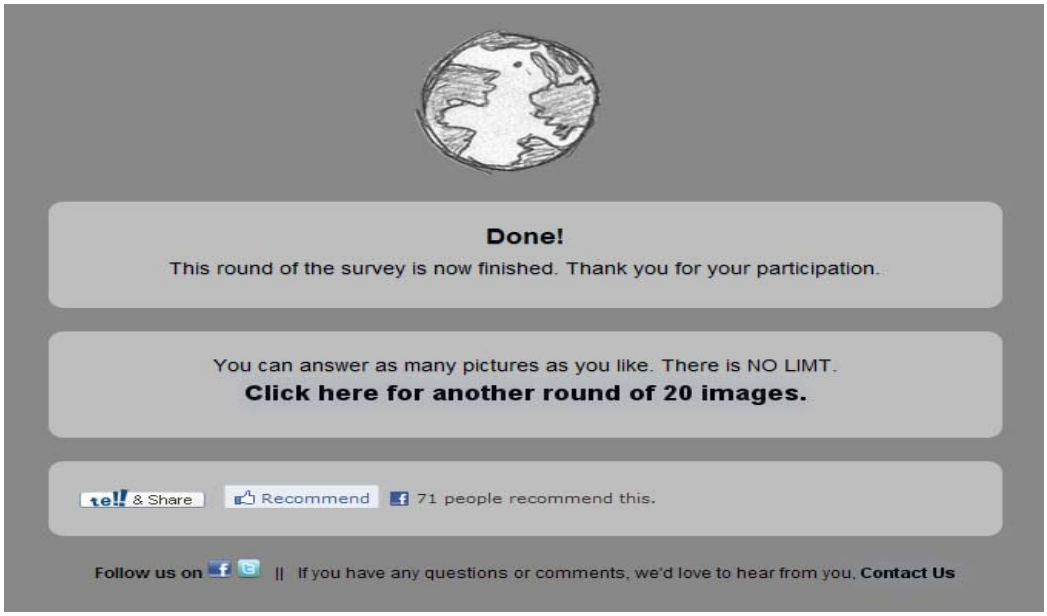

Figure 5.8: End of survey

5.8. Worldwide survey

As stated earlier in the chapter the scope of this thesis involves only one city (Muenster, Germany). However we were interested to study photos that belong to entire world over a period of 6-8 months, which would be an extension of this thesis work. We have developed “Worldwide Survey” that

deals with any place on the earth that has geotag pictures under public domain on Flickr website. During the introduction screen user has to select the “Worldwide Survey” and in next screen select the city of his/her choice (Figure 5.9) and start the survey. Once the city is selected the survey process is same as Muenster survey. One change in the end screen (Figure 5.10) here compared to Muenster Survey is here user can continue with another set of 20 pictures for the selected city or select a new city to start the survey.

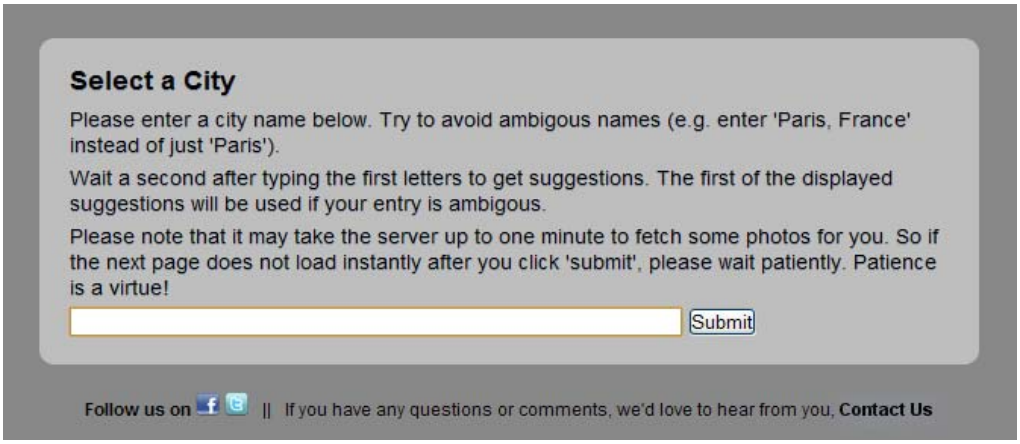

Figure 5.9: City selection.

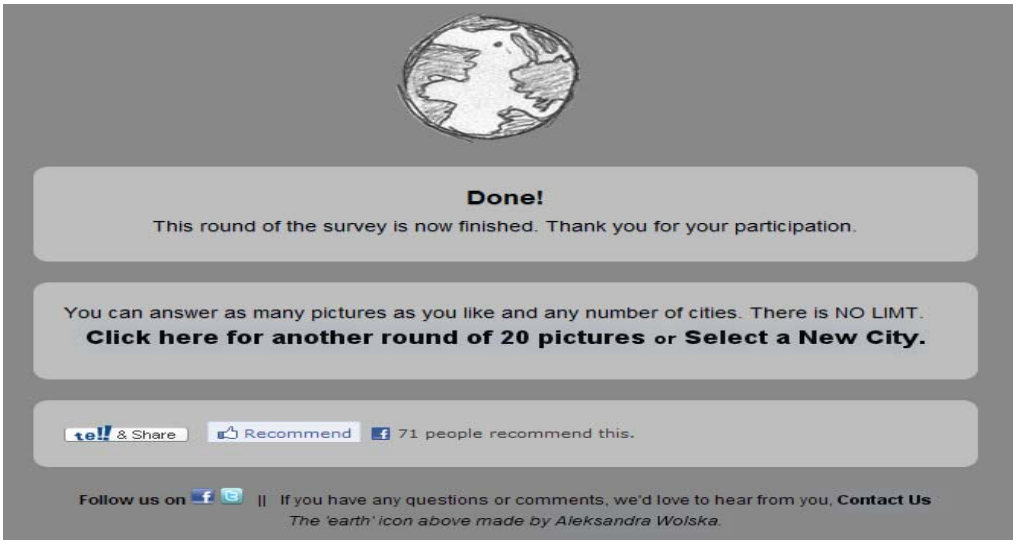

Figure 5.10: End of Worldwide Survey

6. Survey results

In this chapter we analyze the results of online survey conducted from July 2010 till September 2010. The survey was conducted for 1000 most popular pictures of Muenster from year 2008 and 2009.

6.1 Characteristics of participants

The survey was performed by 239 unique users. They answered three questions about their familiarity with the subject (geography), computers and the location (Muenster in this case) before starting the survey. This data helps us to understand the background of users who participated in the survey.

	Geography subject		**Computer usage**	
	Participants	**Percent**	**Participants**	**Percent**
Not Familiar	72	30	19	8
Familiar	167	70	220	92
Total	**239**	**100**	**239**	**100**

Table 6.1: Survey participant's familiarity with geography subject and computer usage

Familiarity with Muenster		
	Participants	**Percent**
Not familiar	38	16
Bit familiar	32	14
Often visit	9	4
Ex-residents	30	13
Residents	130	54
Total	**239**	**100**

Table 6.2: Survey participant's familiarity with study area (Muenster)

Based on this data most of the users participated in the survey are familiar with geography subject, computer usage and location (Muenster). The

following chart shows that 70% of the participants were direct traffic and remaining 30% came from referring websites where the survey link was advertised.

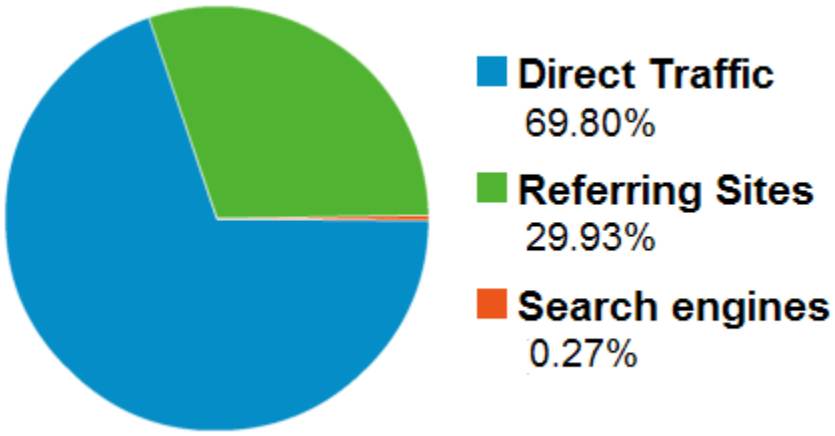

Fig 6.1: Participants traffic flow data

It was a quite a challenge to so many users to perform the survey and since the requirement was higher it took longer than expected to complete it.

Our target was to get answers for 1000 pictures but we get definite answers for 708 pictures from these 239 participants. So we would consider only 708 most popular geotag pictures from 2008 and 2009 for our analysis. We assumed that collective decision about a picture and its metadata is more accurate than a individual decision. So these 708 pictures were repeated minimum 6 times and a maximum of 11 times to different users. The answers of the majority were taken into consideration in judging the picture and its metadata. A total of 5,332 responses were received for the 708 pictures. On an average each picture was repeated 7.5 times before a decision was made about the picture and its metadata.

6.2 Geography vs. non-geographic feature pictures

Out of 708 pictures 198 of them (28%) were categorized by users as pictures that show recognizable geographic features of Muenster and that rest 510 pictures (72%) as non geographic in nature. These 708 pictures were manually verified to check the accuracy of the survey results. It was found that the 193 out of 198 pictures (approx 97.5% accuracy) marked as geographic in nature were true and only 2 out of 505 (approx 100% accuracy) marked as non geographic were geographic in nature.

6.3 Accuracy of geotags

Based on the survey results 71% of the pictures are geotagged to right location, 16% pictures are geotagged close to the actual location, 5% pictures are geotagged to wrong location and 8% pictures, participants did not give a definitive answer. We reviewed these pictures and their geotags and found the ground situation is different from survey results primarily due the ambiguity in judging some the pictures as right location or near to right location. If we group these pictures (right location + near by) together and compare, then the survey results say 87% pictures are in right location or near to the right location and in reality it is 89%.

Geotag	Survey Results	Percentage	Reality	Percentage
Right Location	141	71%	159	82%
Near by	32	16%	13	7%
Wrong location	10	5%	16	8%
Undecided	15	8%	5	3%
Total	198	100%	193	100%

Table 6.3: Comparison between reality and survey results about geotags

Three out of 16 pictures tagged to wrong location were due to bulk uploading. Which means bulk uploading amounts to 19% error in geotags.

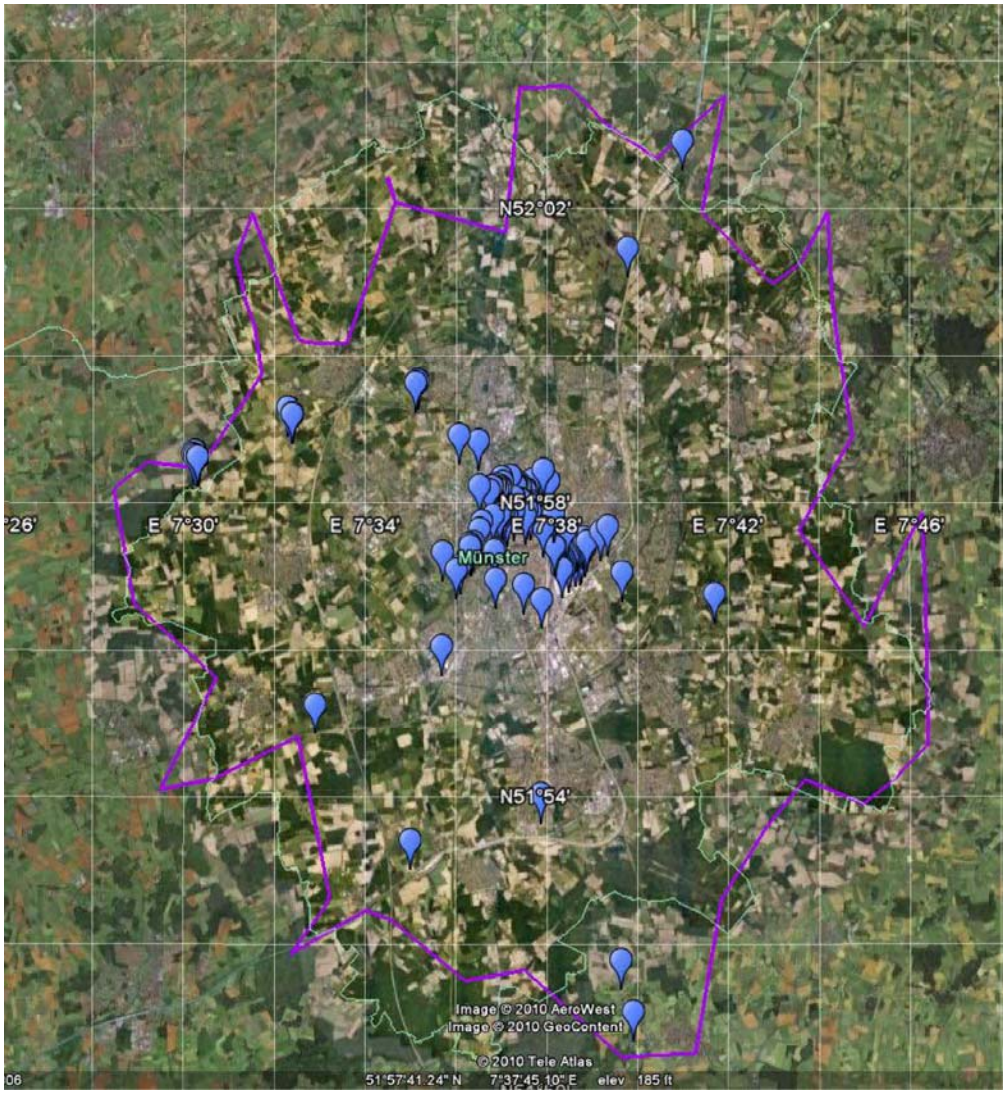

Figure 6.2: Map with geolocations of pictures that show recognizable geographic feature(s) of study area.

6.4 Tags

Analyzing tags was difficult as some of the participants selected tags that do not represent the place name. The focus of this research is on tags linked to pictures that show recognizable geographic feature(s) of the study area. So we analyzed only tags associated with198 pictures that were marked as geographic in nature. We found 628 tags out of 2629 (total) tags are place name tags, which is 24%.

Percentage (place name tags / Total tags]	Number of pictures
0%	21
1-10%	16
10-20%	49
20-30 %	30
30-40%	35
40-50%	18
50-60%	14
60-80%	11
80-100%	4

Table 6.4: Place name tags Vs Non-place name tags percentage

Pictures without any place name tags: 21

Pictures with just one place name tag (Muenster or Münster or Muensterland or Münsterland: 46

6.5. Results discussion and outlook

From reviewing the results displayed in section 6.1, 6.2, 6.3 and 6.4 the following observations can be made of the study area:

1. On an average while searching Flickr database for pictures, one can expect to find 1 in 4 pictures (around 25%) to show some recognizable geographic feature(s) of a place. Any application that needs only pictures that's show geographic features of a place should be aware that the data they collect has 80% noise that needs to be filtered before they use the data.
2. Pictures are generally searched by tags or by their location. Based on the survey results we got, searching by location information (geotag) can provide better results than tags.
3. Among geotag pictures that show recognizable geographic feature(s) of a place, around 90% of them are tagged to right location or to a nearby

location. I think the website is providing better geotag service to its users and also the users are making an effort to tag their pictures to the location where it belongs to.

4. Based on table 6.4, 11% of the pictures don't have any place name tags. If a user searches Flickr database using place name , say "Munester" then the data he/she gets only 90% of total data.
5. On an average 25% of the total tags associated with a picture are place name tags. It shows that place names are often used as tags.
6. The survey study area was just one medium sized city and the remarks may hold good the study area but cannot be generalized entire collections of Flickr pictures. As part of the future work we started to conduct survey for cites all over the world, which would take couple more months to complete. Once we have this date we could make more generalized statements about geotag pictures.
7. These results provide a meaningful insight into the metadata associated with geotag pictures .
8. The participants did a good job in judging the pictures and their metadata. They were close to 98% accurate in their judgment. These results support the idea of using online survey with crowdsourcing as a tool to analyze the geotag pictures and its metadata.